

What is NASA's Mission?



- Safely fly the Space Shuttle until 2010
- Complete the International Space Station (ISS)
- Develop a balanced program of science, exploration, and aeronautics
- Develop and fly the Orion Crew Exploration Vehicle (CEV)
 - Designed for exploration but will initially service ISS
- Land on the Moon no later than 2020
- Promote international and commercial participation in exploration



"The next steps in returning to the Moon and moving onward to Mars, the near-Earth asteroids, and beyond, are crucial in deciding the course of future space exploration. We must understand that these steps are incremental, cumulative, and incredibly powerful in their ultimate effect."

- NASA Administrator Michael Griffin October 24, 2006

NASA's Exploration Roadmap

NASA

05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25...

Exploration and Science Lunar Robotics Missions



Research and Technology Development on ISS

Commercial Orbital Transportation Services for IS

Space Shuttle Operations

SSP Transition

Ares I and Orion Development

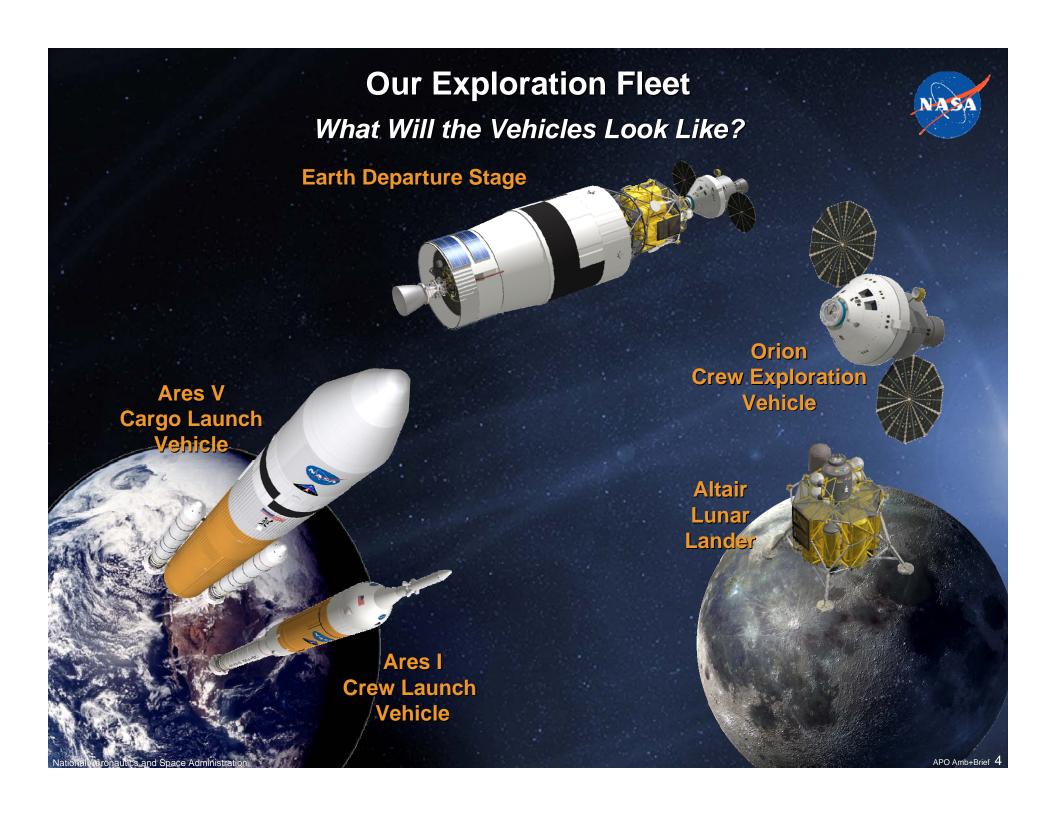
Operations Capability Development
(EVA Systems, Ground Operations, Mission Operations)

Ares I-X Test Flight April 2009 Orion and Ares I Production and Operation

Altair Development

Ares V & Earth Departure Stage

Surface Systems Development



Building on a Foundation of Proven Technologies - Launch Vehicle Comparisons -122 m-(400 ft) Crew Altair Lunar 91 m-£ (300 ft) Lander Orion **Earth Departure** Overall Vehicle Height, m Stage (EDS) (1 J-2X) 253.0 mT (557.7K lbm) LOX/LH₂ S-IVB (1 J-2 engine) **Upper Stage** 108.9 mT (1 J-2X)(240.0K 137.0 mT 61 m-LOX/LH₂ (200 ft) (302K lbm) LOX/LH₂ S-II (5 J-2 engines) 453.6 mT **Core Stage** 5-Segment (1,000.0K lbm) (6 RS-68 Engines) Reusable LOX/LH₂ 1.587.3 mT Solid Rocket 30 m -(3,499.5K lbm) Booster S-IC (100 ft) (RSRB) LOX/LH₂ (5 F-1) 1,769.0 mT 2 5.5-Segment

Space Shuttle

Height: 56.1 m (184.2 ft) Gross Liftoff Mass: 2,041.1 mT (4,500.0K lbm) Payload Capability: 25.0 mT (55.1K lbm) to Low Earth Orbit (LEO) Height: 99.1 m (325 ft) Gross Liftoff Mass: 927.1 mT (2,044.0K lbm) Payload Capability: 25.5 mT (56.2K lbm) to LEO

Ares I

Ares V

RSRBs

Saturn V

Height: 110.9 m (364 ft) Gross Liftoff Mass: 2,948.4 mT (6,500K lbm) Payload Capability: 44.9 mT (99K kbm) to TLI 118.8 mT (262K lbm) to LEO

DAC 2 TR 6 LV 51.00.48

lational Aeronautics and Space Administration

(3,900.0K lbm)

LOX/RP-1

Ares I Elements



Encapsulated Service Module (ESM) Panels

Instrument Unit

- Primary Ares I control avionics system
- NASA Design /

Boeing Production (\$0.8B)

Stack Integration

- 927.1 mT (2,044.0K lbm) gross liftoff mass (GLOM)
- 99.1 m (325.0 ft) in length
- NASA-led

Orion CEV

First Stage

- Derived from current Shuttle RSRM/B
- Five segments/Polybutadiene Acrylonitrile (PBAN) propellant
- Recoverable
- New forward adapter
- Avionics upgrades
- ATK Launch Systems (\$1.8B)

Upper Stage

- 137.1 mT (302.2K lbm) LOX/LH₂ prop
- 5.5-m (18-ft) diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- Reaction Control System (RCS) / roll control for first stage flight
- Primary Ares I control avionics system
- NASA Design / Boeing Production (\$1.12B)

Upper Stage Engine

Interstage

- Saturn J-2 derived engine (J-2X)
- Expendable
- Pratt and Whitney Rocketdyne (\$1.2B)

First Stage





Tumble Motors (from Shuttle)



Mass: 733 mT (1,616 lbm)

Thrust: 15.8 MN

Burn Duration: 126 sec

Height: 53 m (174 ft)

Diameter: 3.7 m (12 ft)

Composite Frustum

Modern Electronics

12-Fin Forward Segment

Same propellant as Shuttle (PBAN)-Optimized for Ares Application

Same cases and joints as Shuttle

Booster Deceleration Motors (from Shuttle)

Wide Throat Nozzle



Same Aft Skirt and Thrust Vector Control as Shuttle

Upper Stage



Instrument Unit (Modern Electronics)

BUEING

Helium Pressurization Bottles

Common Bulkhead

Propellant Load: 138 mT (304K lbm)

Total Mass: 156 mT (344K lbm)

Dry Mass: 16.3 mT (36K lbm)

Dry Mass (Interstage): 4.1 mT (9K lbm)

Length: 25.6 m (84 ft) **Diameter:** 5.5 m (18 ft)

LOX Tank Pressure: 50 psig LH₂ Tank Pressure: 42 psig

LOX Tank

LH₂ Tank

Al-Li Orthogrid Tank Structure

Feed Systems

Ullage Settling Motors

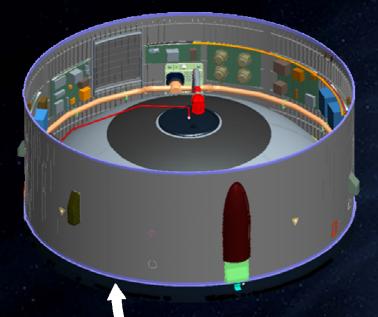
> Roll Control System

Thrust Vector Control

Composite Interstage

Upper Stage Avionics





The Upper Stage Avionics will provide:

- Guidance, Navigation, and Control (GN&C)
- Command and data handling
- Pre-flight checkout

Instrument Unit Avionics

Aft Skirt Avionics
Interstage Avionics
Thrust Cone Avionics



Avionics Mass: 1.1 mT (2,425 lbm)

Electrical Power: 5,145 Watts

J-2X Engine Used on Ares I and Ares V



Turbomachinery

• Based on J-2S MK-29 design

Gas Generator

 Based on RS-68 design

Engine Controller

 Based directly on RS-68 design and software architecture

Regeneratively Cooled Nozzle Section

Based on long history of RS-27 success

Mass: 2.5 mT (5,511 lbm)

Thrust: 131 mT (289K lbm) (vac)

Isp: 448 sec (vac)

Height: 4.7 m (15.4 ft)

Diameter: 3.05 m (10 ft)

- Flexible Inlet Ducts

• Based on J-2 & J-2S ducts

Open-Loop Pneumatic Control

• Similar to J-2

HIP-bonded MCC

 Based on RS-68 demonstrated technology

Metallic Nozzle Extension

New design



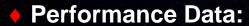
Pratt & Whitney Recketdyne, Inc.

Ares I Lunar Mission Profile Main Engine Cutoff (MECO) Spacecraft Time = 591.8 seceparation Main Engine Start Time = 126.9 sec Burn Duration = 465.0 sec - 10 Altitude = 58,456 m (191.8 K ft)**Maximum Axial** Mach = 5.88Acceleration **Orbital Insertion** 3.79 g Altitude = 129,600 m (70 nmi)) Time = 103.9 sec-20.4 x 185.200 m Altitude = 37,797 m (124.0 K ft) $(-11.0 \times 100.0 \text{ nmi}) = 21.7$ Mach = 4.81**Launch Abort System** Dyn. Press. = 6.6 kN/m^2 (LAS) Jettison (137.4 psf) Time = 156.9 sec **ESM Panel Jettison** Altitude = 82,177 m (269.6 K ft)Time = 153.9 sec Mach = 7.18Altitude = 79,997 m (262.5 K ft)Mach = 7.01**Upper Stage** Solid Rocket Booster Reentry and (SRB) Separation Time 125.8 sec **FSB** Reentry **Breakup** and Descent Altitude 57,463 m (188.5K ft) Mach 5.86 Max Altitude 101,704 m (333.7K ft) Dynamic Pressure = 5.6 kN/m² (116.5 psf) **ESM** – Encapsulated Service Module **Maximum Dynamic Pressure FSB – Forward Segment Booster** Time = 63.2 sec**GLOM – Gross Liftoff Mass** Altitude = 13,103 m (43.0 K ft)Mach = 1.73LAS - Launch Abort System Dynamic Pressure = 37.0 kN/m² **MECO - Main Engine Cutoff** (772.4 psf) SRB - Solid Rocket Booster US - Upper Stage **Upper Stage** Liftoff **Impact** Time = 0.6 secLaunch Thrust-to-Weight Ratio = 1.57 (Indian Ocean) Gross Liftoff Mass (GLOM) = SRB 927.1 mT (2,044.0K lbm) Splashdown DAC 2 TR 6 APO Amb+Brief 11 National Aeronautics and Space Administration

Ares I–X Test Flight



- Demonstrate and collect key data to inform the Ares I design:
 - Vehicle integration, assembly, and KSC launch operations
 - Staging/separation
 - Roll and overall vehicle control
 - Aerodynamics and vehicle loads
 - First stage entry dynamics for recovery





	Ares I-X	Ares I
First Stage Max. Thrust (vacuum):	14.1 MN	15.8 MN
Max. Speed:	Mach 4.7	Mach 5.84
Staging Altitude:	39,600 m (130K ft)	57,700 m (188K ft)
Liftoff Weight:	816 mT (1,799K lbm)	927 mT (2,044K lbm)
Length:	99.7 m (327 ft)	99.1 m (325 ft)
Max. Acceleration:	2.46 g	3.79 g

Ares V Elements





Stack Integration

J-2X

- 3,704.5 mT (8,167.1K lbm) gross liftoff mass
- 116.2 m (381.1 ft) in length

EDS

Payload Fairing

Loiter Skirt

Interstage

Solid Rocket Boosters

 Two recoverable 5.5-segment PBAN-fueled boosters (derived from current Ares I first stage)

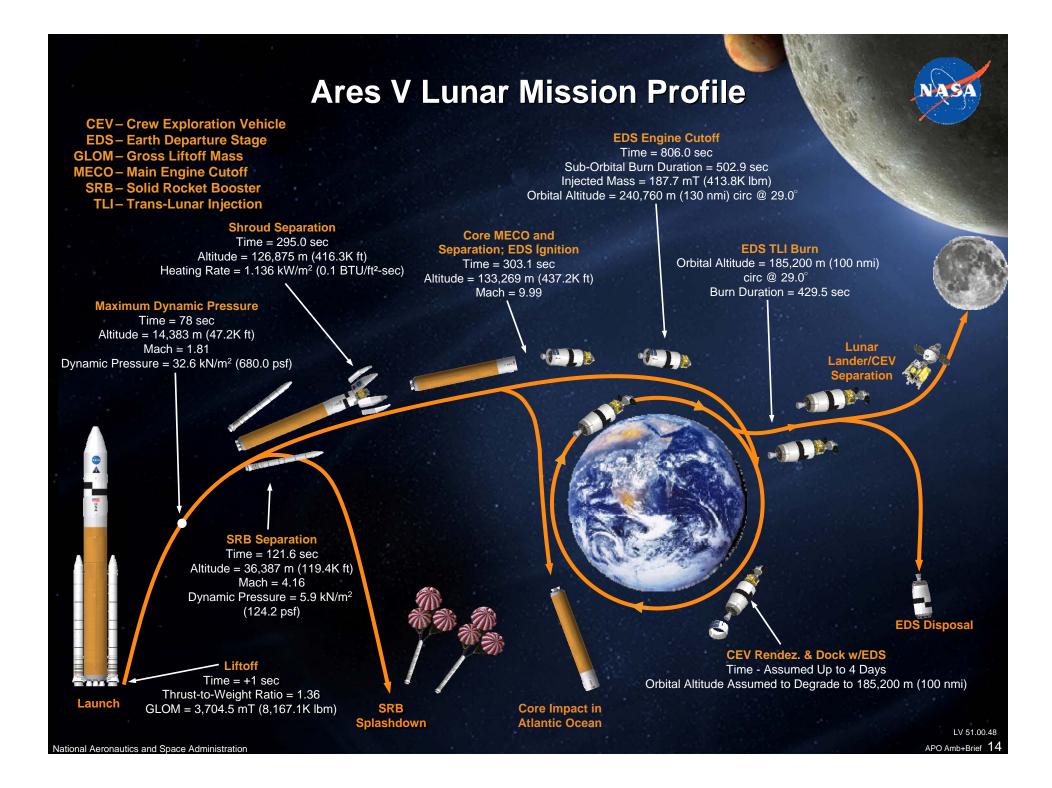
Earth Departure Stage (EDS)

- One Saturn-derived J-2X LOX/LH₂ engine (expendable)
- 10-m (33-ft) diameter stage
- Aluminum-Lithium (Al-Li) tanks
- Composite structures, instrument unit and interstage
- Primary Ares V avionics system

Core Stage

- Six Delta IV-derived RS-68 LOX/LH₂ engines (expendable)
- 10-m (33-ft) diameter stage
- Composite structures
- Aluminum-Lithium (Al-Li) tanks

RS-68



What Progress Have We Made?



Programmatic Milestones

- Completed Ares I and Element System Requirements Reviews, System Definition Reviews, and Preliminary Design Reviews
- Contracts awarded for building the first stage, J-2X engine, upper stage, instrument unit, and Orion
- RFP issued for MSFOC Contract at MAF
- Ares I-X test flight scheduled for 2009

Technical Accomplishments

- Testing first stage parachutes and developing nozzles
- Constructing new J-2X test stand at Stennis Space Center
- Performing J-2X injector tests and power pack tests
- Fabricating Ares I-X hardware
- Robotic Weld Tool installed and operational at MSFC



Cutting Dome Gore Panels for LH₂ Tank



Powerpack 1A at SSC

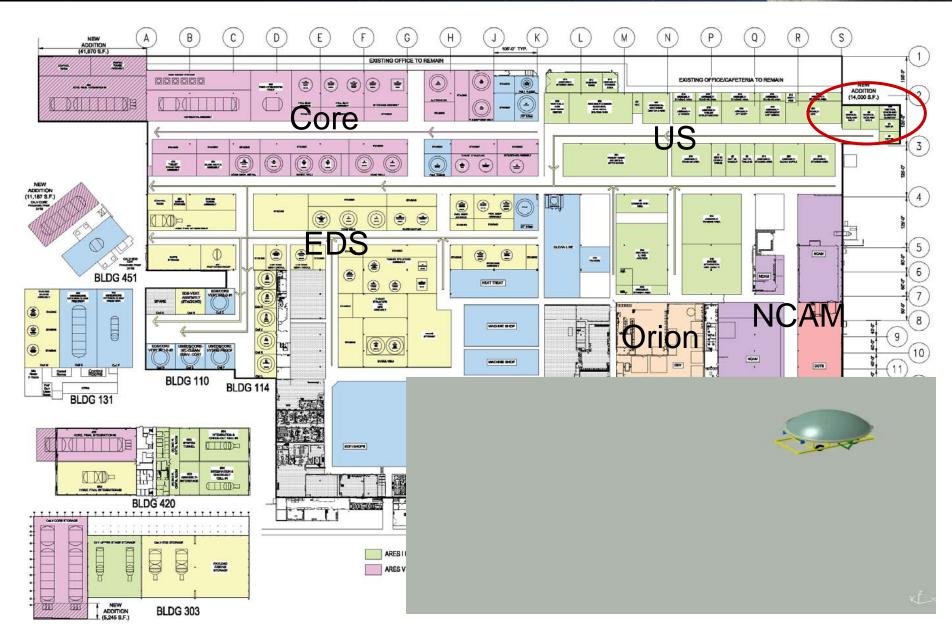


Robotic Weld Tool for Friction Stir Welding



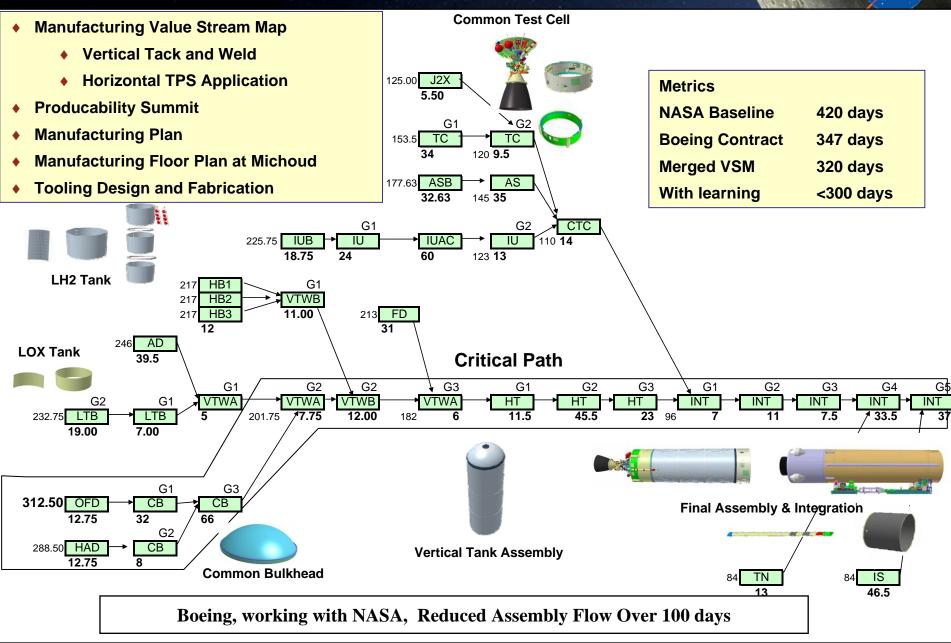
Ares I and V Production at Michoud Assembly Facility (MAF)

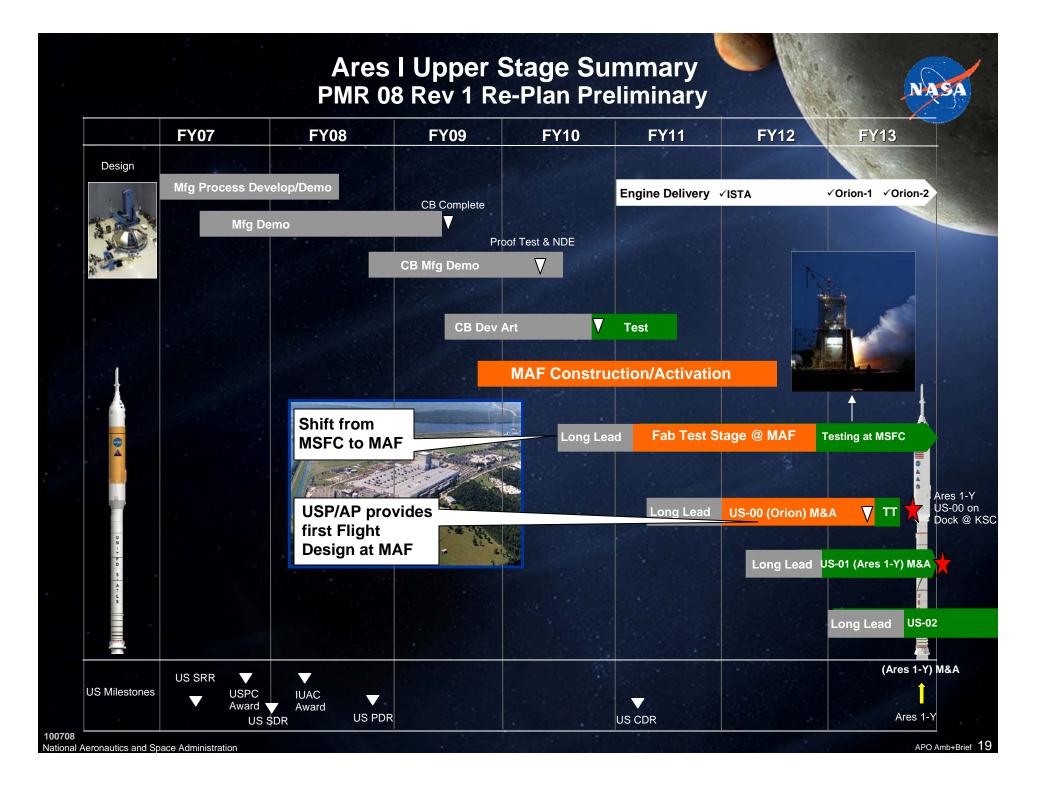




Merged Manufacturing Flow







Summary

- The Ares family will provide the U.S. with unprecedented exploration capabilities
 - Can inject ~40% more mass to the Moon than Apollo/Saturn
- The Ares team has made significant progress since its inception in October 2005
 - Full team is onboard
 - All major milestones met to-date, with PDR completed late Summer 2008
 - Ares I-X test flight is on schedule for 2009
- We are making extensive use of lessons learned to minimize cost, technical, and schedule risks
- The NASA-led / Contractor partnership is very effective in developing the Ares I



